

REMARKS

The present Amendment amends claims 1, 11 and 20, leaves claims 2-10 and 12-19 unchanged and adds new claims 21-24. Therefore, the present application has pending claims 1-24.

Claims 1, 11 and 20 stand objected to due to informalities noted by the Examiner in paragraph 4 of the Office Action. Various amendments made throughout claims 1, 11 and 20 to correct the informalities noted by the Examiner. Therefore, Applicants submit that this objection is overcome and should be withdrawn.

Claims 1-9 and 11-20 stand rejected under 35 USC §102(b) as being anticipated by Kedem (U.S. Patent No. 6,154,853); and claim 10 stands rejected under 35 USC §103(a) as being unpatentable over Kedem in view of Kodama (U.S. Patent Application Publication No. 5001/0012442). These rejections are traversed for the following reasons. Applicants submit that the features of the present invention as now more clearly recited in claims 1-20 are not taught or suggested by Kedem or Kodama whether taken individually or in combination with each other as suggested by the Examiner. Therefore, Applicants respectfully request the Examiner to reconsider and withdraw these rejections.

Amendments were made to independent claims 1 and 11 and 20 so as to more clearly recite features of the present invention. Particularly, amendments were made to the claims to more clearly recite that the present invention is directed to a disk array device and method for storing data in response to communications from a host device. According to the present invention, the disk array device includes a disk array control unit which

performs control of the entire disk array device, a host side data transfer control unit which controls data transfer to and from the host device, a disk array including at least a plurality of data disk drives which constitute one parity group and one or more spare disk drives, wherein the one parity group has a large number of data stripes which are formed over storage areas of the plural data disk drives and the large number of data stripes can be partitioned into two or more sets of data stripes. The disk array device further includes a cache memory which is used for temporarily storage of data to be transferred between the host device and the disk array and subordinate side transfer control unit which controls data transfer to and from the disk array.

According to the present invention, the disk array control unit includes a prediction section which predicts the likelihood of occurrence of a failure for each data disk drive. The disk array control unit also includes a disk drive resource information table which includes for each data disk drive information indicating a status of the data disk drive and information of a rate of occurrence of errors in the data disk drive, and a spare disk drive resource information table which includes for each spare disk drive information indicating a status of the spare disk drive and information regarding storage areas of the spare disk drive used for recovery with respect to a corresponding data disk drive.

As per the present invention the prediction section predicts the likelihood of occurrence of a failure based on information contained in the disk drive resource information table. A divided data copy section included in the disk array control unit, in response to a prediction that failure is likely to occur with respect to a data disk drive, and based on information contained in the

spare disk drive resource table, selects two or more data disk drives out of the plural disk drive as object of divided data copy and selects two or more divided storage areas by selecting one divided storage area from each of the selected two or more data disk drives wherein the selected two or more divided storage areas belong to different sets of data stripes in the parity group. Further, the divided data copy section controls the subordinate side transfer control unit and the cache memory so as to copy data in the selected two or more divided storage areas to one or more spare disk drives.

The above described features of the present invention now more clearly recited in the claims any of the references of record particularly Kedem and Kodama whether taken individually or in combination with each other as suggested by the Examiner.

Kedem teaches a method and apparatus for dynamic sparing in a RAID storage system. Particularly, Kedem teaches, for example, in col. 4, line 63 through col. 5, line 33 that the storage system determines whether a device 34 is beginning to experience too many input/output errors in response to request for reads or writes of data. Kedem teaches that the storage system begins writing the data from the failing device to one of the spare devices within the system so as to create mirrored volumes. Further, as taught by Kedem once mirrored volumes have been created from the spare devices, the storage system will continue to operate until the number of the I/O errors exceed a second threshold level wherein the data volume maybe placed in write disable state.

Thus, Kedem teaches what would appear to be the prediction of failure based upon the number of I/O errors that may occur in a data disk drive.

However, Kedem fails to teach or suggest numerous features of the present invention as recited in the claims.

Particularly, Kedem do not teach or suggest the above described features of the present invention regarding the disk drive resource information table and the spare disk drive resource information table and the information stored respectively therein. As per the present invention as recited in the claims, the disk drive resource information table includes for each disk drive information indicating a status of the disk drive and information of a rate of occurrence of errors in the data disk drive.

Further, according to the present invention as recited in the claims the spare disk drive information table includes for each spare disk drive information indicating a status of the spare disk drive and information regarding storage areas of the spare disk drive used for recovery with respect to a corresponding data disk drive.

As clearly recited in the claims both the disk drive resource information table and the spare disk drive resource information table are used in a manner so as to first perform divided data copy at one threshold and then to perform dynamic sparing at another threshold. These features of the present invention are illustrated, for example, in the flowchart of Fig. 5. Therein, it is shown that an error rate level is determined according to Step 900 based on the disk drive resource information table and whether a spare disk exist as per Step 910 is determined based upon information contained in the spare disk drive resource information table. Such features are clearly not taught or suggested by Kedem. There is no teaching or suggestion in Kedem of both a data disk drive resource information table and information stored therein as

recited in the claims and a spare disk drive resource information table and the information stored therein as recited in the claims. Nor is there any teaching or suggestion in Kedem that such information stored in the respective tables are used to perform various functions as in the present invention.

Thus, Kedem fails to teach or suggest that the disk array control unit includes a disk drive resource information table which includes for each data disk drive information indicating a status of the data disk drive and information of a rate of occurrence of errors in the data disk drive as recited in the claims.

Further, Kedem fails to teach or suggest that the disk array control unit includes a spare disk drive resource information table which includes for each spare disk drive information indicating a status of the spare disk drive and information regarding storage areas of the spare disk drive used for recovery with respect to a corresponding data disk drive as recited in the claims.

Still further, Kedem fails to teach or suggest that the prediction section predicts the likelihood of occurrence of a failure based on information contained in the disk drive resource information table as recited in the claims.

Still further yet, Kedem fails to teach or suggest a divided data copy section which, in response to prediction that occurrence of a failure is likely to occur with respect to a data disk drive, and based on information contained in the spare disk drive resource information table, selects two or more data disk drives out of the plural disk drives as objects of divided data copy, selects two or more divided storage areas by selecting one divided storage area from each of the selected two or more data disk drives, the selected two or more storage areas belonging to different sets of the data stripes in the parity group, and controls the subordinate side transfer control unit and the cache

memory so as to copy data in the selected two or more divided storage areas to one more spare disk drive as recited in the claims.

Therefore, Kedem fails to teach or suggest the features of the present invention as now more clearly recited in the claims. Accordingly, reconsideration and withdrawal of the 35 USC §102(b) rejection of claims 1-9 and 11-20 as being anticipated by Kedem is respectfully requested.

The above noted deficiencies of Kedem are not supplied by any of the other references of record. Particularly, the above described features of the present invention shown above not to be taught or suggested by Kedem are not supplied by Kodama. Accordingly, combining the teachings of Kedem and Kodama in the manner suggested by the Examiner in the Office Action still fails to teach or suggest the features of the present invention as now more clearly recited in the claims.

Kodama is merely relied upon by the Examiner for an alleged teaching of the storing of an error occurrence history for each of the data disk drives. However, there is no teaching or suggestion in Kodama of the above described features of the present invention regarding the disk drive resource information table, the spare disk drive resource information table, the respective information stored therein and the use of such information contained in said tables by the prediction section and the divided data copy section as in the present invention as recited in the claims.

Thus, the features of the present invention as now more clearly recited in the claims are not taught or suggested by Kodama and as such when combined with Kedem fails to teach or suggest the features of the present invention as now more clearly recited in the claims. Therefore, the

combination of Kedem and Kodama fails to teach or suggest the features of the present invention as now more clearly recited in the claims. Accordingly, reconsideration and withdrawal of the 35 USC §103(a) rejection of claim 10 as being unpatentable over Kedem in view of Kodama is respectfully requested.

The remaining references of record have been studied. Applicants submit that they do not supply any of the deficiencies noted above with respect to the references utilized in the rejection of claims 1-20.

As indicated above, the present Amendment adds new claims 21-24. New claims 21-24 recite many of the same features shown about to not be taught or suggested by any of the references of record, particularly Kedem and Kodama, whether taken individually or in combination with each other. New claims 21-24 also recite further features not taught or suggested by Kedem or Kodama whether taken individually or in combination with each other. An explanation of said further features is provided below.

In the divided copying process according to claims 21-24, only the divided storage area of each selected data disk drive is copied to a spare disk, but the other storage area of each selected disk drive is not copied. Thus, as recited in the claims not only the divided storage areas, but also the other storage areas contains (net) data that is not parity data. In contrast, according to Kedem, all of the net data except parity data in a disk are copied to a spare disk when the disk malfunctions.

In other words, in the divided copying process according to new claims 21-24, only the divided storage areas of the selected data disk drive is copied to a spare disk, but the other storage areas of the selected data disk drive is not copied to the spare disk. In contrast to the present invention as recited in

the claims, in the copying process according to Kedem, a data volume is copied to a spare disk, but a parity volume is not copied to the spare disk.

Thus, the divided copying process according to new claims 21-24 do not achieve the substantial duplex of the data disk drive, since it copies only a partial storage area (i.e., the divided storage area) of the disk, drive but does not copy the other storage areas containing the net data of the same disk drive. However, the copying process according to Kedem achieves a substantial duplex of the disk drive, since it copies all the net data in the disk drive to the spare disk. Therefore, the copying process taught by Kedem is time consuming since a substantial duplex of the disk drive occurs.

According to new claims 21-24, the duplex is not achieved until the probability of a data disk failure occurring reaches the second level. However, according to the present invention the divided copying process being performed in advance reduces the amount of data which have to be copied in order to achieve duplex when the probability reaches the second level. Such features as now recited in the claims are not taught or suggested by Kedem.

The above described features of new claims 21-24 are also not taught or suggested by Kodama. Thus, both Kedem and Kodama suffer from the same deficiencies relative to new claims 21-24.


Therefore, the combination of Kedem and Kodama fails to teach or suggest the features of the present invention as recited in new claims 21-24.

In view of the foregoing amendments and remarks, applicants submit that claims 1-24 are in condition for allowance. Accordingly, early allowance of claims 1-24 is respectfully requested.

To the extent necessary, the applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, or credit any overpayment of fees, to the deposit account of MATTINGLY, STANGER, MALUR & BRUNDIDGE, P.C., Deposit Account No. 50-1417 (WL-5063).

Respectfully submitted,

MATTINGLY, STANGER, MALUR & BRUNDIDGE, P.C.



Carl I. Brundidge
Registration No. 29,621

ClB/jdc
(703) 684-1120